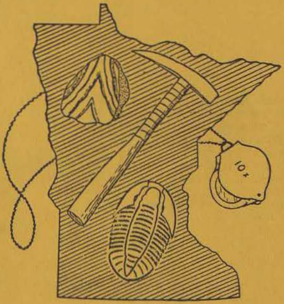

Geological Society of Minnesota

NEWS

Geological Society of Minnesota

Marcia Gunville, Editor
1110 Gardena Ave.
Fridley, Minn. 55432

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Dr. Matt Walton
Minnesota Geological Survey
1633 Eustis Street
St. Paul, MN 55108

Jan.-Feb.-March, 1978

OFFICERS

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	Sr. Joan Kain	1035 Summit Ave., St. Paul	225-3000
	Allen Lundgren	765 Redwood Lane, New Brighton	633-5442

MURPHY'S LAW:

If anything can go wrong, it will.

Corollaries:

1. Nothing is as easy as it looks.
2. Everything takes longer than you think.
3. If there is a possibility of several things going wrong, the one that will cause the most damage will be the one to go wrong.
4. If you perceive that there are four possible ways in which a procedure can go wrong, and circumvent these, then a fifth way will promptly develop.
5. Left to themselves, things tend to go from bad to worse.
6. Whenever you set out to do something, something else must be done first.
7. Every solution breeds new problems.
8. Anytime things appear to be going better, you have overlooked something.
9. It is impossible to make anything foolproof because fools are so ingenious.

O'TOOLE'S COMMENTARY ON MURPHY'S LAW

Murphy was an optomist.

MINNESOTA GEOLOGICAL SOCIETY

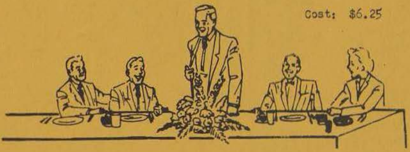
SPRING BANQUET

Monday, April 24, 1978

Hennepin Ave. United Methodist Church
Lyndale and Groveland Ave's.
Minneapolis

Time:
6:00 - Punch
6:30 - Dinner

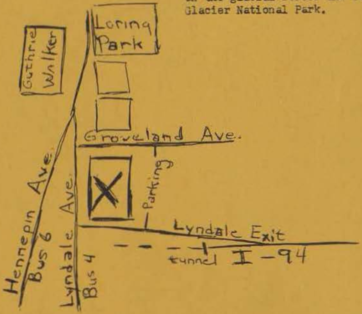
Cost: $6.25



SPEAKER

PROF. WILLIAM GIRARD
Department of Geography
Mankato State College

Prof. Girard will give a slide presentation on the glacial forces and features of Glacier National Park.



MENU: Chicken Kiev

RESERVATIONS must be in by **April 10.** Checks should be made out to Minn. Geological Society and mailed to:
Mrs. Dale Johnson
11310 County Rd. 15
Minneapolis, MN 55441

GEOLOGICAL SOCIETY OF MINNESOTA

ANNUAL FINANCIAL STATEMENT 12-31-76 to 12-31-77

INCOME				
Dues for 1977	$291.50			
1978	467.00			
	$755.50	755.50		
Field Trips		188.00		
Banquet		394.07		
Coffee		46.80		
		$1,384.37	$1,384.37	
EXPENSES				
Bank Costs		13.05		
Membership		41.85		
Program				
Lectures		480.00		
Programs		54.10		
Public Service		55.49		
Banquet		385.34		
Newsletter		247.27		
Field Trips		180.00		
Rosters		41.05		
Misc.		25.42		
		$1,523.57	1,523.57	
DEBIT			$ 139.20	
Interest on Savings			228.25	
CREDIT			$ 89.05	
Checkbook Balance -- January 1, 1978				$ 325.64
Balance Savings Accounts				3,805.71
				$ 4,131.35

Robert V. Leacock
Treasurer

FIELD  TRIPS

Field trips this summer will give G.S.M. members a chance to learn first hand about the geology of many parts of Minnesota. Bob Gunville, Field Trip Chariman, has announced a stimulating series of trips with excellent leadership. The schedule is as follows:

Sat.-Sun., June 3-4 -- Geology of the Ely-Tower Area (tentative)
with Dr. R. W. Ojakangas, Univ. of Minn. Duluth

This will be a two-day bus trip, with overnight accommodationa at Burntside Lodge, in the heart of Minnesota's beautiful canoe country. We will be studying the earliest geologic history of Minnesota and some of the oldest rocks in the state.

Dr. Ojakangas is a recognized expert on this area. He has studied it extensively and led the Geological Society of America (national professional organization) on a field trip here in 1972 during their annual meeting.

Sat., July 22 -- Caves and Related Geology of Southern Minnesota
with Dr. Calvin Alexander, Univ. of Minn.

The trip will go by bus to the limestone country of Southern Minnesota, into the area around Spring Valley and Mystery Cave. A tour of Mystery Cave will be one of the activities.

Dr. Alexander is a geologist who is doing current research on caves and related hydrological studies. He is working on a continuing mapping project of Mystery Cave.

Sat., Aug. 5 -- The Geology of the Upper Mississippi River Valley
with Dr. Robert Sloan, Univ. of Minn.

Dr. Sloan will lead the group on a one-day bus trip to see a variety of terranes traversed by the Mississippi River on its route into the Twin Cities. We will be interpreting geological features of many ages.

Dr. Sloan will show us how such features are currently being made, and how vastly different environments also have affected the rocks. He will point out glacial and post-glacial events. We will literally go through a metamorphic episode as we travel up toward St. Cloud and beyond, and learn how different degrees of pressure and temperature change the rocks in a progressive way.

Dr. Sloan has planned to take us as far north as Little Falls. He regularly leads his geology students on this interesting field trip.

Sat.-Sun., Sept. 9-10 -- A Canoe Trip With a Northwoods Audubon Naturalist

The group has been invited to spend the weekend at the Northwoods Audubon Center. This trip will feature canoeing on the Kettle River to see the geology from the perspective of the stream. We will spend about four hours each day with a naturalist on the water (going downstream). He will be able to interpret not only the geology, but also the plant and animal life of the natural scene.

Four meals (2 lunches, dinner, breakfast), overnight accommodations, and canoes will be provided. This is always a very pleasant, as well as a stimulating weekend. If you have not been to Northwoods before, be sure to consider this opportunity.

If you might be interested in attending any of these trips, be sure your name is on the Field Trip Calling List. Call Bob Gunville (574-1421).

welcome NEW MEMBERS:

We would like to welcome the following new members into the G.S.M.:

Erlene Elliott
4616 W. 111th St.
Bloomington, MN 55437

Colin Connel
3737 18th Ave. S.
Minneapolis, MN 55407

Janet N. Williams
175 Co. Rd. B2, Apt. 416
St. Paul, MN 55117

Carl R. Erikson
2120 4th St.
White Bear Lake, MN 55110

Stephen Baker
2705 Colfax Ave. S.
Minneapolis, MN 55408

Margaret K. Baskin
1021 5th St. S.E.
Minneapolis, MN 55414

Patricia M. Donahue
813 University Ave. S.E., #201
Minneapolis, MN 55414

Everett R. Smith
2225 W. 105th St.
Bloomington, MN 55431

Evaline R. Dautermann
5317 27th Ave. S.
Minneapolis, MN 55417

Robert Mitchell
12312 Parkwood Dr., Apt. 317
Burnsville, MN 55337

The following people have changed addresses:

Helen Woodward
4515 Grand Ave. S., Apt. 4
Minneapolis, MN 55409

Mrs. S. Koonz (Ruth)
2818 Golden Valley Road
Minneapolis, MN 55411

William J. and Patty O'Brien
1199 Fallsview Court
Mendota Heights, MN 55118

U. OF M. SAMPLER LECTURE IS OF INTEREST

"Formation of the Mississippi River and the Retreat of St. Anthony Falls" is the title of a Sampler Lecture presented by the University of Minnesota Extension Division. It will be held on Tuesday, May 9, 7:30 p.m. in Room 140 Nolte Center, Minneapolis Campus. Julie Stein, Geology, Center of Ancient Studies, will be the speaker.

Sampler Lectures are a series of one-evening special public lectures on a wide variety of topics. This year they all are being held at Nolte Center. Cost for an individual lecture is $1.00, or four lectures for $3.00, persons 62 and older free. For more information call 376-7500.

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G.S.M. EXHIBITS AT MINNESOTA MINERAL CLUB SHOW

The G.S.M. was invited to set up an exhibit booth at the Minnesota Mineral Club's annual show, held April 1 and 2 at Maplewood Mall. Dr. Alex Lowe, Exhibits Chairman, arranged to have a display where people could try their skills at mineral identification. This is a large mineral show, attracting a great many people. We were happy to be able to participate.

# # # # #

ROCKS OF LAKE SUPERIOR'S NORTH SHORE TELL G.S.M. FIELD TRIPPERS A STRANGE STORY

(continued from the last G.S.M. News)

by Marcia Gunville

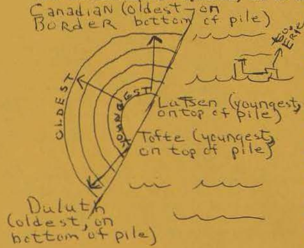
Is Minnesota a neighbor to Wisconsin today because of some early, fortuitous change in the Earth's grand design? Those of us on the G.S.M. field trip last June to Lake Superior's North Shore wondered about this idea.

It's hard to imagine what might have happened here if geologic processes begun during the Late Precambrian Period had not been aborted. Might an ocean separate us from Wisconsin today? About 1.0 - 1.2 billion years ago the continental crust along Minnesota's eastern border was slowly ripping apart. This ancient rift zone extended in a north-south belt from Canada to Kansas.

Dr. David Southwick, Macalester College, led our field trip group to the North Shore of Lake Superior where we could see the rocks in this early rift zone. He showed us some of the evidence convincing geologists that this interpretation of its geologic history is correct. He also showed us a number of primary structural features of the rocks here, some of the many different aspects taken on by these igneous rocks when formed. Throughout time, geologic events shaped the lovely scenery of today's North Shore Drive. Dr. Southwick put the history of this area into a perspective that covers some 1½ billion years of time.

The story began long before Lake Superior was here, or the Late Precambrian rift zone had even occurred. Earlier in time, Middle Precambrian seas once covered the area. We looked at the evidence for their existence (see the last issue of the G.S.M. News). During the Late Precambrian Period, at this rift zone, flow after flow of lava was extruded from a great opening in the Earth's crust, and injection after injection of intrusive magma was forced into the existing rocks below ground. Then the Lake Superior Basin warped downward into a great syncline. The story continued on into the Pleistocene when glacial ice moved down this synclinal basin, then melted back again. It is still going on today as the waters of Lake Superior actively carve out the shoreline profile we see, and streams cut their beds down through the Late Precambrian rocks, exposing them further to our view.

This presumed rift zone was volcanically active for several hundred million years during the Late Precambrian Period. From it lava flows piled up on top of one another in a very thick sequence. Still later, when the rocks became downwarped into the Lake Superior Syncline, all of these lava flows were tilted gently toward the center of the lake. The effect on the land here was much like imagining someone taking a stack of dinner plates, tilting them slightly in an eastward direction, planing them off (through erosion) and then letting the waters of a lake wash up against them. The bottom of the stack is exposed at the outer edges, the top of the stack is exposed in the center, and the layers in between represent a progressive order from older to younger. The shoreline of Lake Superior crosses the oldest lava flows at Duluth and continues past a succession of younger beds toward the center of the volcanic pile. Then it crosses progressively older beds once again going on toward the Canadian border. The geologic map in our handout material demonstrated how this tilting made the rock units outcrop in



arclike bends. We knew we were moving up and down the stratigraphic column as we traveled past different rocks along the highway.

The lava flows began at a time when the Earth's magnetic field was reversed, and the older rocks have this reversed magnetic polarity frozen into them. The younger lava flows were extruded during the time when the Earth's magnetic field had changed and become normal. Their rocks show a normal magnetic polarity within them. By studying the polarity indicated in these rocks, geologists can help correlate events of the Late Precambrian Period.

The many lava flows we examined often were very different from one another. Their colors (mineral contents) might be different. They could have different types of holey, swiss-cheese vesicles. The lava flows sometimes had large crystals (phenocrysts) as part of their composition. Sometimes they had secondary minerals (agate, calcite, thomsonite, various zeolites) within their vesicles. Some flows were very thin. They might be as small as six inches. Others were very thick and massive. Palisade Head is a single lava flow.

Certain outward features, such as a ropey appearance, might be created when the liquid lava was cooling. By solidifying as it flowed along, it would make such flow patterns, much like the flow patterns stirred into fudge as it hardens. The rocks commonly had cracks (joints), made as the volcanic material cooled still further and contracted, or when the rocks reacted to metamorphic conditions. Often such cracks had become filled with different colored veining materials, striping it in unusual designs. Or magma could have squirted into such cracks, forming dikes or sills. Sometimes rocks had broken up into rubble (breccia) along the slip surfaces of earthquake movements. There were places where original minerals in the rocks had become completely altered to new minerals as a result of burial and subsequent metamorphism, or as a result of contact with heated, mineral-rich waters.

We quickly learned to recognize tops and bottoms of individual lava flows. Tops were the bubbly portions of the volcanic rocks, where gases had tried to escape from the hot lava but couldn't get out before the material hardened. The bubble holes are called vesicles. Bottoms were the solid portions of the rocks. Gases had been removed from these parts of the flows. We could see a number of lava flows at our lunch stop in Gooseberry Falls State Park. Here the water of the Gooseberry River shoots over these individual flows in beautiful cascading waterfalls.

Along the shore near Cascade Lodge, our overnight stop, Dr. Southwick showed us some unusual vesicles. To us they appeared spectacular, as huge vesicle-filled tubes leading down into the mass of the rock as chimney pipes lead down into houses to their basement fireplaces. Dr. Southwick called these large tubes vesicle cylinders. He said that they are a widespread phenomenon in certain thick basalts but are not well understood. For some reason the gases in these lavas chose to collect together in one place before coming to the surface. Then they rose together to the top of the flow, and left long vesicle cylinders in the otherwise ordinary lava flow.

Some outcrops we passed were not like the fine grained rocks we had seen, formed by lavas which had flowed out onto the surface. They were too coarse grained for that, indicating slower cooling underground. Large quantities of magma from the rift zone never got to the surface. Many pulses were pushed into the rocks underground and remained at deeper levels. Magma cooling deep within the earth solidifies more slowly, forming rocks with larger crystals such as gabbro, diabase or granite. Now that erosion has worn away the overlying rocks in a number of places, these rocks are exposed as the vast Duluth and Beaver Bay Complexes.

Dr. Southwick explained to us that the materials of lava flows can differ widely chemically, depending on the environment in which they are formed. Certain kinds of lavas tend to be more abundant in situations which favor their formation. Lavas produced in a tensional (pulling apart) environment tend to be mostly of basalt (chemically close to one extreme), secondarily of rhyolite (chemically close to the other extreme), and very little of andesite (chemically in between). He called this a bimodal suite, and showed us that basalts and rhyolites were the rock types we were seeing here, in about the correct percentages. Since a rift zone would be such a tensional environment, the fact that the proper percentages of basalts and rhyolites are here is considered good evidence for its being a former rift zone. Different types and percentages of lavas would occur in other situations. He contrasted this suite with the one to be expected in an island arc environment, which would be largely andesite (trivial here), secondarily basalt (by far the most important here), and rhyolite uncommon (plentiful here).

Some lavas are made of stickier, highly viscous materials. Flow patterns of such lavas were obvious. Sometimes gas bubbles were dragged out in bands. Sometimes color banding resulted from different parts of the lava flowing past one another. Some slight turbulence might cause the thick material to create small swirls or eddies. We saw such rock patterns. Phenocrysts, internal crystals, often became aligned in a preferred orientation.

Dr. Southwick explained how phenocrysts are formed. Deep underground, magma may begin to cool within a magma chamber. Because it is cooling slowly, it forms large crystals. If the same magma chamber later becomes filled with additional magma, these large crystals become scattered throughout the mush. If this new material then forces its way up to the surface, it will carry with it the large crystals. Because it cools quickly on the surface, it forms a fine grained rock with large crystals, the phenocrysts, scattered here and there like raisins in a muffin. Such rocks are said to have a porphyritic texture. We saw rocks with unusually large phenocrysts. They were plagioclase crystals four to five inches long, lined up in a linear fashion according to the direction this lava had flowed.

At one stop we saw an interesting dike cutting across a porphyritic lava flow. It had been formed by magma forcing its way into a zone of weakness. This dike was made up of two kinds of material. It looked like its magma had segregated into long bands before cooling. This had not been the case, according to Dr. Southwick. He called it a composite intrusion. Two separate intrusions of magma had entered the same zone of weakness. The first magma had a slightly different composition from the second magma. On cooling, it had a different appearance, creating the layered effect. He said that many dikes have composite intrusions. If a dike has a small band running down the center, appearing to split apart a single kind of dike rock, it probably is a composite intrusion.

Hot, gummy magma often has other materials, such as phenocrysts, included in it. But inclusions are not restricted to crystal-like sizes. At one stop we saw a large outcrop of anorthosite, a type of gabbro which is almost entirely plagioclase. It was surrounded by more ordinary gabbro on both sides. We also saw a peculiarly oriented block of common volcanic rock. We could find its bubbly top and solid bottom, but they were turned in the wrong direction. This one outcrop had a top and bottom oriented opposite to those of all the volcanic rocks we had seen up and down the entire North Shore. Both the anorthosite and the strangely situated volcanic rock turned out to have been immensely large chunks of loose rock, giant inclusions floating around within a magma body. The anorthosite had been a chemical differentiate separated from the rest of the magma, now gabbro. The volcanic rock had come from the wall rock containing the younger magma. Magma had ripped it out from the chamber wall, then carried it upward in twisting and turning motions. It finally had come to rest in its reversed position.

We stopped at a large road cut overlooking Good Harbor Bay, the site of a geological plaque erected by the G.S.M. a number of years ago. Sedimentary rocks occur here, interbedded with lava flows. Volcanism must have been inactive for long periods, allowing time for erosional and depositional processes to build up these layers of sandstone. When volcanism again became active, hot lava once again blanketed everything.

Dr. Southwick showed us how to deduce from the rock evidence the sort of environment this had been during the quiescent erosional period. The sandstone had features such as crossbedding and mud cracks. It must have been deposited in shallow water, probably by streams or in lakes.

When volcanism again resumed, and superheated lava suddenly rolled over this watery terrain, the water was quickly changed to steam. The effects on the lava flow were explosive. As steam forced its way toward the surface it smashed and pulverized whatever volcanic materials were in its way. There were heavily brecciated zones, some with chunks of broken-up rocks of all sizes. Certain sites had been literally blasted apart as the gas and steam vented its way toward the surface. These zones also had undergone mineral alteration from contact with the steam. We could see the sites of steam flow very plainly, as the rest of the rock was quite ordinary. Under each shattered portion of this rock there had been a site of water, and a source of steam.

Glaciers covered this region during the Pleistocene. During the time of their final melting, Lake Superior became a larger lake than it is today with much higher shorelines. We saw some of these former shorelines. At one place our road was built on the terrace cut by the waves of this enlarged glacial lake.

Waves still are carving out the shoreline. We could see this very well from our windy lookout at the end of Shovel Point. We had climbed out to the end of this massive rhyolite flow as the weather was changing to rain. Still the view was magnificent. To the south we could see Palisade Head jutting upward. Palisade Head is another rhyolite flow, the next unit up in the volcanic pile. In between, the rocks had been eroded away.

This particular rhyolite had been a very viscous lava flow. It formed a big cliff here, but according to Dr. Southwick it did not flow very far inland, pinching out about three miles away. It probably had its feeding centers close by. We could see the sawtoothed profile of the terrain against the skylike. It was shaped this way by the ridges of individual lava flows inclining toward the lake. They were tilted in this direction by the downwarping of the Lake Superior Basin. We could also see wave cut terraces and sea arches along the present shoreline. The winds and waves were splashing hard up against the rocky shore, amply demonstrating for us the way they do their work in carving out such features.

Lake Superior has always been a gem of Minnesota's scenery. A trip to the North Shore would be a treat just to view it. We gained much more than beautiful views, however. On this field trip we learned something about this scenery's special significance. Dr. Southwick provided us a first hand opportunity to work out some of its complex puzzles. He gave generously of his expertise in interpreting Earth history from rocks, and helped us to learn a little about how this is done. His lessons were thorough and carefully taught in an atmosphere of fun and enthusiasm. We'd all like to thank him for a very stimulating weekend.

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